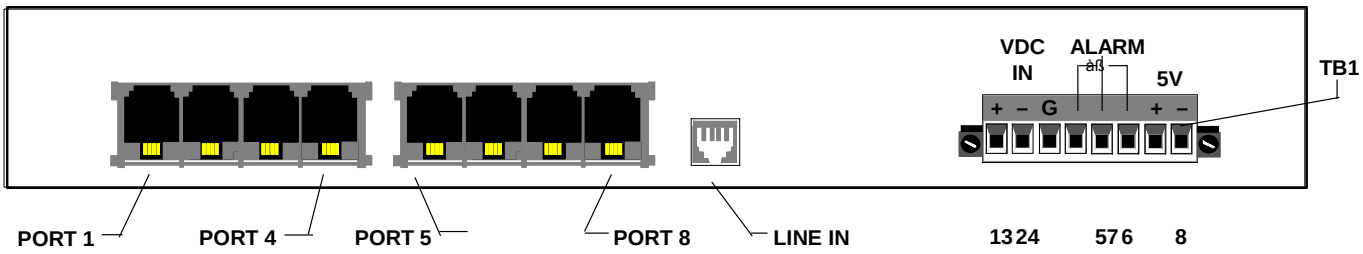
INSTRUCTION INFORMATION

PROGRAMMABLE AUDIO LINE SWITCH
G-9420

GENERAL DESCRIPTION

The Programmable Audio Line Switch (PALS), model G-9420, allows the customer to access devices within the substation from a single telephone communications line with only one call to the station. Once the G-9420 has answered, a window of time opens to allow direction of the call to one of the eight ports. If the call is not directed using DTMF tones, the G-9420 defaults to and rings port 1 after approximately 10 seconds. When communication to a port is complete, the user may redirect the call to another port once that device has gone on-hook. Port 1 is typically used for the handset in the station. A station emergency requiring use of this handset disconnects all other ports when port 1, or the handset, goes off-hook.

FIGURE 1



INSTALLATION

POWER CONNECTIONS:

The top of the case is labeled to show what system voltage the PALS is configured to operate on. Note that the 125Vdc unit operates on both 125Vdc and 115Vac. The power input is wired with the "+" or "L" of ac into the "+" input on TB1, terminal 1. The "-" or "N" of ac connects to the "-" input at TB1, terminal 2. The chassis ground connection at TB1, terminal 3, is very important for the protective circuitry of the PALS; therefore, connect it to a very good ground.

TELEPHONE CONNECTIONS:

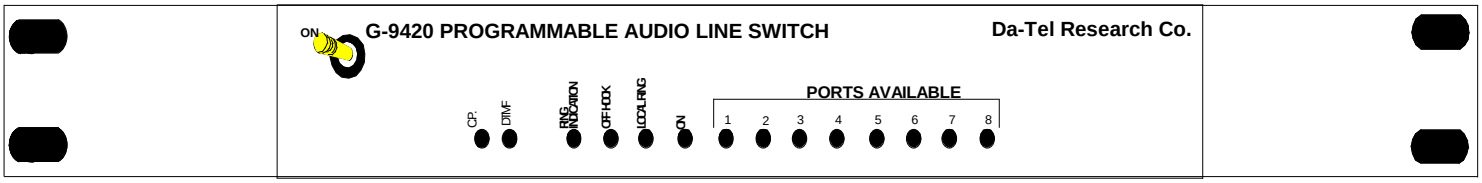
All telephone lines are terminated on a 2-wire, RJ-11 connector. If a 4-wire plug is used, the middle pair of contacts, usually red and green wires, is used by the PALS for communication. The LINE IN jack is for connecting the PALS to the line entering the building or station from the telephone company. The other 8 RJ-11 jacks connect the PALS to the devices in the station. Port 1 is the recommended port for the local station telephone since it may be programmed to interrupt all other ports.

AUXILIARY CONNECTIONS:

The G-9420 is provided with an alarm relay output at TB1, terminals 4, 5 and 6. This relay contact toggles when the power is turned off on the unit or the microcontroller fails to run. This relay follows the green "ON" LED on the front panel (see Figure 2). When operating normal, the relay contacts are closed from terminal 5 to 6 and open when power is lost.

The G-9420 internal power supply generates +5Vdc and is made available at

FIGURE 2



terminals 7 and 8. This power may be used for another G-9420 or for 5Vdc modems such as the G-9615A. Up to 1A may be used from this supply without concern.

INDICATORS:

The G-9420 PALS provides many indicators to help the user know what is going on and diagnose any problems (see Table 1).

If port 1 yellow LED flashes on power up, an error has been detected in the time clock for the DTMF decoder. If the port 7 yellow LED flashes, the NVRAM memory space is not available. Note also that the red RING INDICATION LED is merely a flash since the G-9420 answers immediately.

MOUNTING:

The unit may be either 19" rack-mounted or the cover may be removed and the 4 internal ¼" holes used for panel mounting.

TABLE 1

LED LABEL	COLOR	DESCRIPTION	NORMAL STATE
RING Indication	Red	Indicates when an incoming ring signal is being applied to the G-9420.	OFF
OFF HOOK	Yellow	Indicates when the G-9420 has answered and gone off hook. Will go out once port device goes on hook.	OFF, only ON when G-9420 holds the line.
LOCAL RING	Red	Indicates when a port is being rung.	OFF
ON	Green	Indicates when power is on and CPU is running.	ON
PORT 1	Yellow	Indicates when port 1 is available or is off hook.	ON - available or off hook.
PORT 2-8	Yellow	Indicates when a corresponding port is available or off-hook.	ON - available or off-hook.

APPLICATION NOTE
FOR USING TWO G-9420 PALS
TO ACCESS UP TO 15 AUDIO PORTS

GENERAL

This application note encompasses how to apply the Da-Tel G-9420 Programmable Audio Line Switch to an application requiring more than 8 ports but not more than 15.

No special programming of the G-9420s is required to access the second G-9420. The standard, factory configuration was used to test these hardware configurations.

HARDWARE

Figure 3 illustrates a typical application of two Da-Tel G-9420s. All that is required is the addition of devices to the ports to be accessed by the incoming telephone line.

The G-9420 is connected to the station battery according to the marking on the case for polarity. With the two G-9420s operating adjacent to each other, 5 Vdc can be derived from the first G-9420 to power the second G-9420. The switch on the first G-9420 controls the power for both units and the second G-9420's switch is inactive. It is important for noise reduction to connect the ground terminal of the G-9420s to a good ground.

The telephone line into the site should connect with an RJ-11 termination into the G-9420 where marked INCOMING LINE. Port 1 of the G-9420 is typically a local handset for use by the maintenance personnel. Port 8 is used to make connection to the second G-9420, however, any port could be used. Ports 2 through 7 on the first G-9420 and ports 1 through 8 on the second G-9420 are available for dial-up devices. The diagram shows numbering for a 15 port setup.

PORT ACCESS

To access a port between 1 and 7 (2 for example), use the following sequence:

1(303)249-8919,,,2

where the number of commas is dependent on the telephone exchange connect time; three is a good start. To access a port between 8 and 15 (10 for example), use the following sequence:

1(303)249-8919,,,8,3

where this accesses port 10 (port 3 of the second G-9420). The number of commas between the 8 and 3 is dependent on the connect time between the two units, 1 is sufficient. The 8 rings the second G-9420 and the 3 rings the port of interest.

TESTING AND CALIBRATION

GENERAL

The G-9420 Programmable Audio Line Switch (PALS) allows the user to dial into a station over a single telephone line and connect to multiple devices connected to its ports. This device has programmable features that also need checking.

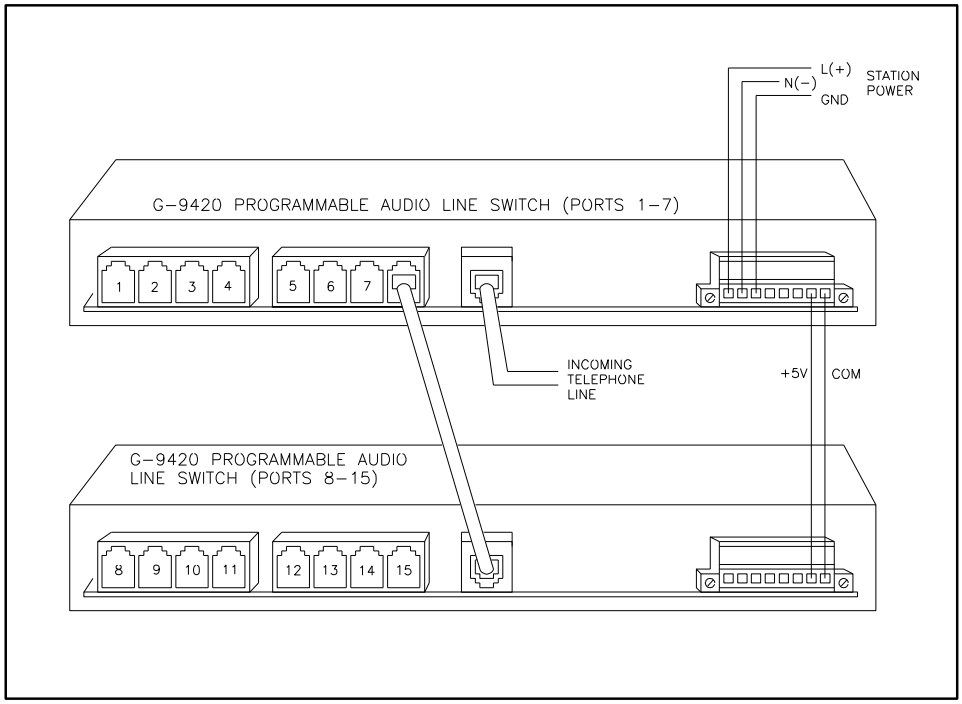


FIGURE 3

SETUP

Connect the dc input power such that the positive (+) is on terminal 1 and the negative (-) is on terminal 2. Connect a ground to terminal 3, also.

A Teltone Line Simulator (TLS) is needed to verify that calls are completed. Connect one port of the TLS to a touch-tone phone and the other port of the TLS to the LINE IN on the G-9420. Multiple phones may be connected to the ports of the G-9420 to have devices to call in to.

TEST PROCEDURE

POWER-UP

Apply power and observe that the green ON LED is lit. The yellow PORTS AVAILABLE LEDs should also be on.

CALL PROGRESS (CP) TONES ADJUSTMENT (Line-In disconnected)

Install J3 on the board this will initate the internal test tone and adjust the test tone level at TP3 to TP7(signal ground) to +3.5 dBm with the front panel trimmer labeled C.P., R11.

DUAL TONE MULTPLE FREQUENCY(DTMF) RECEIVE LEVEL ADJUSTMENT(Line-In disconnected)

Install J3 on the board this will initate the internal test tone. Adjust the test tone level at TP2 to TP7 to -9 dBm with the front panel trimmer labeled DTMF, R10.

FAX DETECT ADJUSTMENT

Line-In may or may not be connected, J3 must be out or not installed. Adjust R46 for 1100Hz at pin 5 or 6 of U26, then inject an 1100Hz -30dbm signal between TP1 and TP7 and observe pin 8 of U26 going low (from 5V to 0V)

PORT RINGS (all ports)

With the TLS and handset connected, check all ports by dialing the G-9420. Connect another phone to each port sequentially and redirect the calling to each port. Check to see that each corresponding port LED lights. Also, when the TLS is ringing, the RING INDICATION LED should light for each ring of the TLS. Then the OFF HOOK LED should light when the G-9420 goes off hook. When a port is ringing, the LOC RING LED should light.

PORT ANSWER (all ports)

With the TLS and handset connected, check that all ports answer by dialing the G-9420. Connect another phone to each port sequentially and redirect the calling to each port. Check to see that each corresponding port LED lights and that the path is complete when the port phone is answered. Depressing keypad numbers is a good check to see if the audio path is good.

ROTARY (all ports)

With the TLS and handset connected, check all ports for rotary service by ringing the TLS phone from each port of the G-9420. If each port rings the TLS phone, rotary option is working.

PRIORITY PORT INTERRUPT

With the TLS and handset connected, connect a phone to port 1 and another to port 2. With the priority port option programmed, dial port 2 of the G-9420 and answer with its phone. Ports 1 and 2 LEDs should be on. Pick up the port 1 phone and observe that the default time delay occurs before control is given to port 1 (port 1 LED lights by itself). Reprogram the G-9420 to disable priority port interrupt and rerun the test to verify that port 1 does not disconnect port 2 (*5720#). Reprogram to priority port interrupt enabled (*5721#).

INTERRUPT DELAY OPTION

Set the priority port interrupt delay code for a longer time, such as 10 seconds (*44100#), and rerun the previous test to verify the programming of the delay. When done, reset the delay to

the default value (*44010#).

DIAL TONE DISCONNECT

With the TLS and a handset connected, connect a phone to port 1. With the phone on port 1 on-hook, momentarily depress the power button on the TLS to ON/RING. With the Dial Tone Detection option enabled, the RING INDICATION LED should illuminate and then go out. Reprogram the G-9420 to disable ring detection (*420#) and observe that the G-9420 remains off-hook until power-off. Reprogram back to enable dial tone detection (*421#).

BILLING DELAY OPTION

With the TLS and a handset connected, dial a port of the G-9420. With the billing delay enabled, a two-second delay should be observed between when the G-9420 goes off-hook and when ringback tones occur in the TLS handset. Reprogram the G-9420 to disable the billing delay (*400#), and observe no delay. Reprogram back to the default of enabled billing delay (*401#).

RINGBACKS

With the TLS and a handset connected, connect a phone to port 1. With the TLS phone, call the G-9420 and count the number of rings before the unit hangs up. This number should match the default. Reprogram the number of rings to 50 (*52150#) and call the G-9420 and verify the number of rings. Reset to the default (*52116#).

PORT 1 CUT-THROUGH

With the TLS and a handset connected, connect another phone to port 1. Power off the G-9420 and see that a call will go through to port 1.

Phone Drive Tes

Attach 5 bell equivalent phones to a port and ring that port. All phones should ring!

FCC TESTS

Apply 1500 Vrms, 60 Hz from T to R of the line in. This should not damage the G-9420. Apply 1500 Vrms, 60 Hz from T and R to the chassis, with no damage to the G-9420. Apply 100 Vrms, 60 Hz to T&R and T&R to chassis of all ports. No damage and no potential present at the line in port or another port should result.

Measure the line out noise level with all phones on-hook. This should be less than -60 dBm.

Measure the ring generator frequency.

Measure the ring generator frequency while ringing a port with one phone on it.

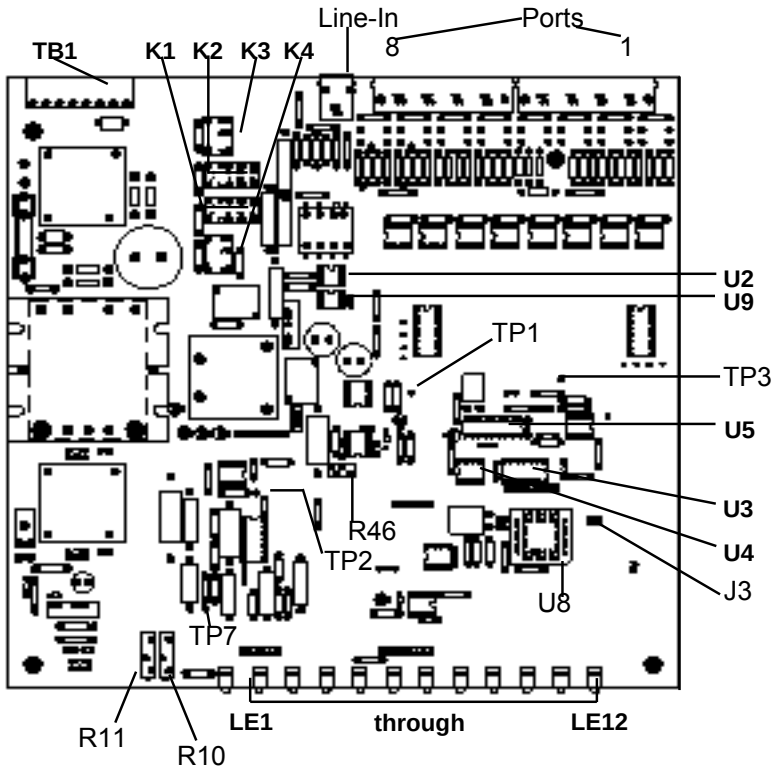


FIGURE 4

Simplified layout of the G-9420

THEORY OF OPERATION

An incoming call to the G-9420 PALS detects ringing voltage, U2, and signals the main processor, U8. The PALS answers immediately by going off-hook. Relay K3 is energized, the front panel LED, LE2, glows yellow and a 600 ohm load is placed across the LINE IN to draw loop current. The call-progress tone generator, U3, is controlled to send a double-beep and indicate to the caller that a window of steering opportunity is available. If a DTMF tone is sent, the DTMF decoder U5, instructs the processor of the tone number sent and then closes the solid-state switch, TS117, that corresponds to that port and a second double-beep is initiated. At this point all the port LEDs extinguish except the port to be called and the priority port if programmed. The processor alternately places loop current and ring voltage on the port using K4. The red LED, LE3, will flash alternately with the port LED (yellow) of the port ringing. If the device on the port goes off-hook during ringing, the ringing voltage collapse detector, U9, will command the ringing to cease immediately. If the device goes off-hook during non-ringing, the TS117 will detect loop current flow and the yellow port LED will go solid. Once the port is determined by either case, the processor connects the port to the line by using K1 and then releases K3 to allow the port device to hold the line off-hook. If multiple connections from one call are enabled, when the port device goes on-hook, the line is again placed off-hook by the PALS before the line is lost to no loop current being drawn. A double-beep is again sent to allow the caller to start the process over again, otherwise the PALS hangs up the line.

If a port device wishes to call out, it must go off-hook and draw loop current from the local voltage source placed on all the ports by K4 and K1. Since the port device has drawn loop current, the PALS lights its LED and the priority port LED if programmed. Also, the PALS connects the port device to the LINE IN using K1 such that the central office goes off-hook. The

port device then functions as normal. However, with a priority port programmed, typically port 1, if the priority device goes off-hook while another port is conversing, the processor will cut off that device and hang up the line. As soon as the central office connected to the LINE IN detects the on-hook condition, the priority device will draw loop current from the central office and then receive a dial-tone.

Some other features are if power is lost, K2 will de-energize and short the LINE IN to port 1 connection allowing at least one outgoing connection to occur. A FAX tone detection circuit listens when a FAX machine normally sends its type 3 tones and, if programmed, may automatically route the call to the assigned port. A dial-tone detector, U4, checks the line for dial-tone after a port has started ringing. This detector is intended to sense when the calling device has gone on-hook and the processor can then terminate the ringing sequence.

SPECIFICATIONS

ENCLOSURE: 19" Rack Mount, 1U High, 10" Deep, aluminum

PANEL MOUNT: 8.85" x 11", 1/4" holes

WEIGHT: 4.5 lbs. maximum

TEMPERATURE RANGE: -20° to +70°C, operating; -35° to +85°C, storage.

SUPPLY ISOLATION: 3500V.

DATA RATE: 14.4kBPS

ON-HOOK LINE IMPEDANCE: >10K ohms.

OFF-HOOK LINE IMPEDANCE: Approx. 600 ohms.

SIGNAL LOSS, Line-to-Port: less than 0.2dB

RINGER EQUIVALENCE: 1.0B

PORT RINGER CAPABILITY: 5.0B, minimum

FCC REGISTRATION NO.: IDFUSA-22979-KX-T

POWER INPUT: 8W, max. at 48Vdc (38V to 63V) 10W, max., at 125Vdc (100V to 200V) or 115Vac (85V to 135V)

TABLE 2

OPTIONS FOR EACH PORT	COMMAND STRING	DEFAULT (factory settings)
Ring On Time Sets the ring on cadence in hundredths of seconds.	*50PXXX# P = 1-8, XXX = 001-999	XXX = 010 (1 second)
Ring Off Time Sets the ring off cadence in hundredths of seconds.	*51PXXX# P = 1-8, XXX = 001-999	XXX = 030 (3 seconds)
Number of Rings Sets the number of rings before disconnecting.	*52PXX# P = 1-8, XX = 01-99	XX = 16 (16 rings)
Tone During Ring On Time Sets the tone that the caller will hear during the Ring On Time.	*53PX# P = 1-8, X = 0-5(See Tone Description)	X = 1 (Ring Tone)
Security Code Enables the requirement for the caller to enter a security code after the port code before access to the port is allowed.	*54PXXX# P = 1-8, XXX = 000-999 (000 disables the security feature)	XXX = 000 (Disabled)
Confirmation Signal Allows the user to enable/disable the Confirmation Signal audible when the port is selected.	*55PX# P = 1-8, X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)
Connection Type Sets the port connection type. This allows for a port to become a Calling, Answer or Normal port.	*56PX# P = 2-8, X = 0-2 (0 = Normal, 1 = Answer, 2 = Calling)	X = 0 (Normal)
Port 1 Interrupt Control Allows the enabling or disabling of the ability for Port 1 interrupts.	*57PX# P = 2-8, X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)
Continuation Port Sets the next port to ring after a connection completion of the current port.	*58PX# P = 1-8, X = 0, 1-8 (0 = Disabled)	X = 0 (Disabled)

Table 2 continued . . .

STEERING WINDOW OPTIONS	COMMAND STRING	DEFAULT
Steering Window Start Indication Enables/Disables the steering window start indication.	*30X# X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)
Steering Window Tone Cycles Sets the number of tone cycles during the window before defaulting to Port 1.	*31XX# XX = 00-99 (0 = skip steering window)	XX = 03 (3 cycles)
Steering Window Tone Sets the audible tone during the Tone On time during the window.	*32X# X = 0-5 (See Tone Descriptions)	X = 1 (Ring Tone)
Steering Window Tone On Time Sets the Tone On time.	*33XXX# XXX = 000-999	XXX = 010 (1 second)
Steering Window Tone Off Time Sets the Tone Off time.	*34XXX# XXX = 000-999	XXX = 030 (3 seconds)
Multiple Connection Window Start Indication Enables/Disables the steering window start indication.	*35X# X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)
Multiple Connection Tone Cycles Sets the number of tone cycles for the multiple connection window. ("*"Enable this command first for all multiple connection commands)	*36XX# XX = 00-99	XX = 00 (Disabled) (0 = Disabled)
Multiple Connection Tone Sets the audible tone during the Tone On time during the multiple connection window.	*37X# X = 0-5 (See Tone Descriptions)	X = 5 (Dial Tone)
Multiple Connection Tone On Time Sets the Tone On time.	*38XXX# XXX = 000-999	XXX = 100 (10 seconds)
Multiple Tone Off Time Sets the Tone Off time.	*39XXX# XXX = 000-999	XXX = 000 (0 seconds)

MISCELLANEOUS OPTIONS	COMMAND STRING	DEFAULT (factory settings)
Billing Delay Enables/Disables the 2 second billing delay.	*40X# X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)
Answer Termination Delay Sets the PABX on-hook delay when an answered call is terminated.	*41XXX# XXX = 000-999 0-99.9 Seconds	XXX = 050 (5 seconds)
Dial Tone Detection Enables/Disables Dial Tone detection.	*42X# X = 0,1 (0 = Disabled, 1 = Enabled)	X = 1 (Enabled)

PROGRAMMING

Table 2 lists all of the features that may be altered using the programming strings shown. The factory defaults are also shown and typically work for 99% of the installations used by our customers. Also, if errors are made in programming, sometimes the G-9420 will respond erratically. To reload the factory defaults, remove the G-9420 cover and install jumper J3, located next to the square shaped processor. Turn the power switch off and then back on (cycle the power), and remove the jumper. The defaults have now been reloaded.

To program a string from Table 2, connect the G-9420 to either a telephone line or a telephone line simulator. Call the unit and when the first double-beep is heard, key in the command string ensuring that the * is the first character entered. When the command string is entered, the G-9420 will respond with a double-beep to indicate that it recognizes the string and has stored the new parameter. The programmer may load one or multiple command strings during the same steering window.

COMMAND STRING CODE DESCRIPTIONS

(DTMF Tones are initiated by the LINE IN telephone key pad)

" * " Enables or starts the ability to program a command string into processor at the time of the steering window.

" # " The "#" sign (DTMF Tone Code) during the steering window will command the G-9420 to hang up or go back ON HOOK. Exception to this is after entering a command string the first "#" tone "sets" command into the processor and if followed by a second "#" tone, will place the G-9420 back ON HOOK.

TONE DESCRIPTIONS

0 = None

1 = Ring Tone (440 and 480Hz)

2 = Low (350Hz)

3 = Mid (480Hz)

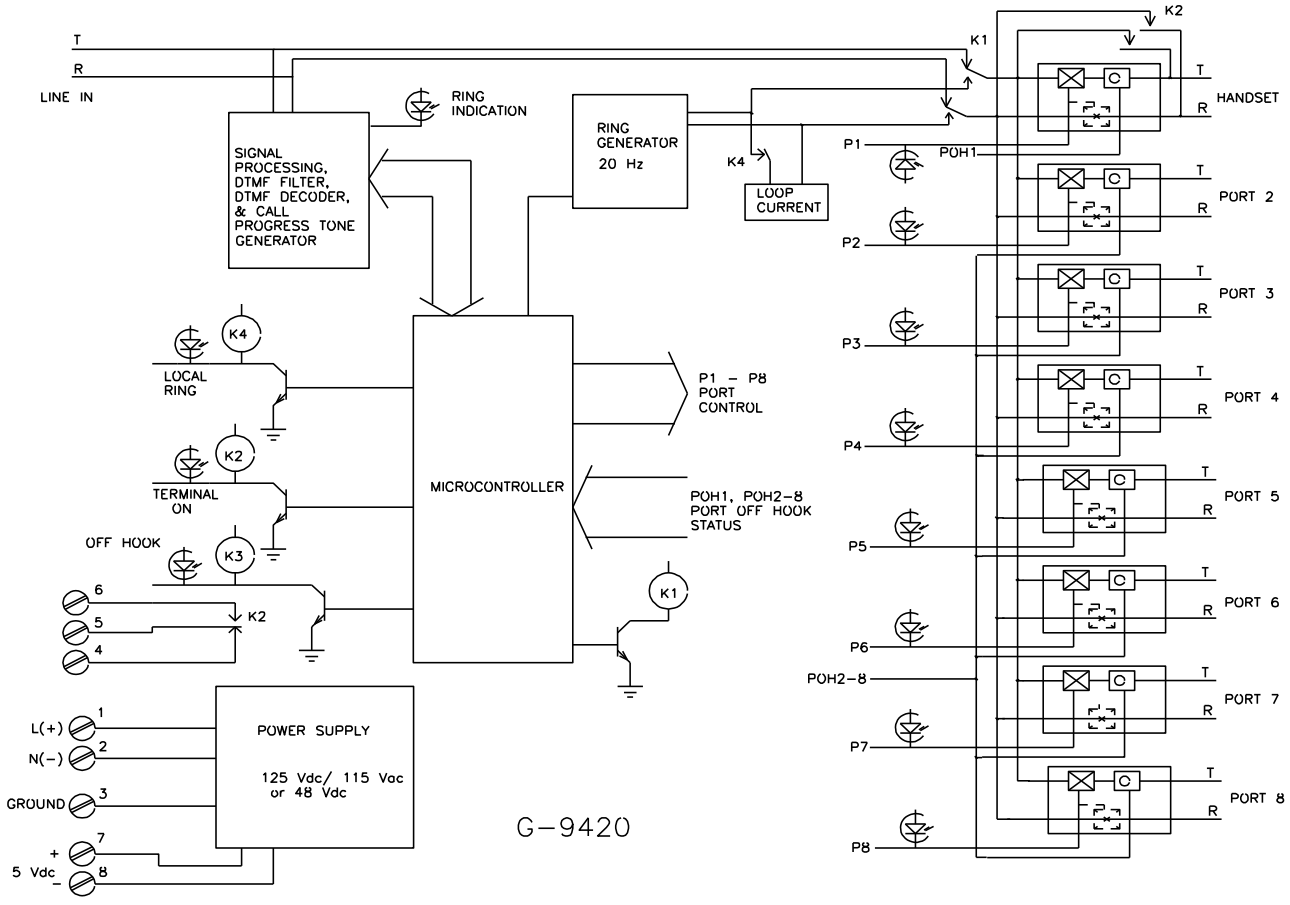
4 = High (620Hz)

5 = Dial Tone (350 and 440 Hz)

P = Port (1-8)

X = Seconds, Tones, Cycles, Enabled or default, # of rings, etc.

FIGURE 5
Simplified block diagram of the G-9420



REPLACEABLE PARTS LIST, G-9420

CIRCUIT SYMBOL	DESCRIPTION	STOCK #
LE1,3	LED, Red, 550-0406	010001
LE4	LED, Green, 550-0206	010002
LE2,5-12	LED, Yellow, 550-0306	010004
CR21-24	Diode, IN4004	010020
CR27	Diode, 1N4148	010040
CR25,26	Diode, IN5234B	010110
CR53-56	Diode, IN5406	010281
CR29-47	Diode, P6KE200CA	010339
C13	Capacitor, EL., 330uf, 16V	020110
C68,69	Capacitor, EL., 470uf, 50V	020111
C12	Capacitor, EL., 220uf, 250V	020130
C4,8,37,46,47,67	Capacitor, TAN., 1uf, 35V TAP	030150
C39,42,45	Capacitor, TAN., 10uf, 16V TAP	030152
C1	Capacitor, TAN., 3.3uf, 16V TAP	030153
C25	Capacitor, TAN., 4.7uf, 16V TAP	030160
C36	Capacitor, TAN., 6.8uf, 16V TAP	030161
C10	Capacitor, TAN., .1uf, 35V, TAP	030162
C19,22	Capacitor, CER., .001uf, 1KV	040000
C5,7	Capacitor, CER., .05uf, 16V	040010
C24,40,43,48,49,50	Capacitor, CER., .01uf, 100V	040030
C27,28	Capacitor, CER., .003uf, 3KV	040060
C26,38,41,44,54,69,70	Capacitor, CER., .1uf, 50V	040080
C51,52	Capacitor, CER AX, 22pf, 100V	040092
C31	Capacitor, MYLAR, 1uf, 200V	050050
C2,23,53	Capacitor, MYLAR, .47uf, 250V	050210
C3,11	Capacitor, FILM, .1uf, 250V	050270
C15	Capacitor, POLY., 3900pf	060470
C14	Capacitor, POLY., 4700pf	060480
C17	Capacitor, WESCO, .00825	070090
C16	Capacitor, WESCO, .011	070150
C20	Capacitor, WESCO, .0187	070260
C18,21	Capacitor, WESCO, .00487	071150
U1,7	I.C., MC14049UBCP	080130
U2	I.C., 4N35	080320
U27	I.C., MC1455P1 NE555N	080550
U9	I.C., H11AA1	080600
U8	I.C., MC68HC705C8CFN	080882
U13,14	I.C., TL082IP	080940
U12	I.C., TL084IN	081170
U5	I.C., CM8870PI	081250
U25	I.C., TL051IP	081309
U3	I.C., M-991	081330
U4	I.C., M-980	081331
U15,22	I.C., TS117	081352
U10	Cambridge, NU-8MR-5V	081482
VR3	Voltage Reg., 115D5FS	081528
U26	I.C., XR567ACP	081534
U24	I.C., AT25040-10PC	081574
Q1-3,7,8	Transistor, 2N3903	090050
Q6	Transistor, 2N3905	090060
Q4	Transistor, IRFZ20	090270
K1,2	Relay, DS2E-MDC5	100205
K3,4	Relay, DS1E-M-DC5V	100206
R10	POT, 43P103	110020
R11	POT, 43P502	110060
R46	POT, 67YR10K	110300
R4,7,16,35-42,64,67	Resistor, COMP., 1/4W, 1K	130030
R45,60,61,65,68,69,73,74,75	Resistor, COMP., 1/4W, 10K	130040
R12,13,15,66	Resistor, COMP., 1/4W, 100K	130050
R6,72	Resistor, COMP., 1/4W, 22K	130150
R14	Resistor, COMP., 1/4W, 4.7K	130260
R9	Resistor, COMP., 1/4W, 10M	130390
R17-34	Resistor, COMP., 10 ohm 1/2W	130731
RN4	RESNET, 8-1-103	139880
RN1	RESNET, 8-1-102	139967
RN3	RESNET, 6-1-103	139970
RN5	RESNET, 8-2-102 (ISO)	139972
RN2	RESNET, 6-1-102	139979
R43	Resistor, PREC., 301.0 3010F	140720
R3	Resistor, PREC., 590.0 5900F	140860
R71	Resistor, PREC., 5.11K 5111F	141310
R5,48,52,56,58	Resistor, PREC., 51.1K 5112F	141790
R51	Resistor, PREC., 53.6K 5362F	141800
R59	Resistor, PREC., 301.0K 3013F	142160
R57	Resistor, PREC., 511.0K 5113F	142270
T1	Transformer, TTPC-13	150390
L3	Inductor, PE-52647	150460
L4-7	Inductor, Miller 77F100K	150461
L1,2	Inductor, PE-62892	150464
L8	Inductor, PE-52651	150467
PJ1,PJ2	Jack, TM2REA-2416	171098
PJ3	Jack, TM5RE1-64	171100
TB1	PHNX: 1776566	171220
TB1	PHNX: 1778043	171221
S1	Switch, 8280K115	180000
F1	Fuseholder, 102074	190110
F1	Fuse, 3AG, 3A	190130
Y2	Crystal, 4.0MHz	250019
MO5-MO11	MOV, V150LA10A	250142
MO1,2,4	MOV, V250LA20A	250143
R1	CL-80	250146
Y1	Crystal, 3.5795 CTX049ND	250740

NOTICE

As of the date of this printing, the specifications for the G-9420 in this Instruction Information sheet apply to all G-9420 Programmable Audio Line Switch, except as indicated. Because all Da-Tel products are continually being refined and improved, these specifications are subject to change without notice.